

## **SECTION 23 34 00**

### **HVAC FANS**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Fans-product requirements.
- B. Centrifugal utility fans.
- C. Tubular centrifugal fans.
- D. Axial vane fans.
- E. Powered roof exhaust fans.
- F. Gravity roof ventilators.
- G. In-line cabinet fans.
- H. Propeller fans.
- I. Wall exhaust fans.
- J. Variable volume units.

##### **1.02 RELATED SECTIONS**

- A. Painting of mechanical equipment and components shall be as specified in Section 09 91 00 - Painting.
- B. Vibration isolation shall be in accordance with Section 20 30 13 - Vibration Isolation and Seismic Control for Facility Services
- C. Air distribution ductwork is specified in Section 23 31 00 - HVAC Ducts and Casings.
- D. Refer to Facility Design, Criteria, Mechanical, Line Sections Article 6 for Emergency Ventilation System.

##### **1.03 MEASUREMENT AND PAYMENT**

- A. General: Separate measurement or payment will not be made for the work required under this Section All cost in connection with the Work specified herein will be considered to be included or incidental to the Work of this Contract.

##### **1.04 REFERENCES**

- A. Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA):
  - 1. AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings

2. AFBMA 11 Load Ratings and Fatigue Life for Roller Bearings

B. Air Movement and Control Association (AMCA):

1. AMCA 99 Standards Handbook
2. AMCA 210 Laboratory Methods of Testing Fans for Rating
3. AMCA 300 Reverberant Room Method for Sound Testing of Fans
4. AMCA 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
5. AMCA 500 Test Methods for Louvers, Dampers and Shutters
6. ARI 410 Standard for Forced-Circulation air-Cooling and Air-Heating Coils
7. ARI 430 Standard for Central-Station Air-Handling Units.
8. ARI Guideline D Application and Installation of Central Station Air-Handling Units
9. ARI 610 Central System Humidifiers
10. NEMA MGI Motors and Generators
11. NFPA 70 National Electrical Code
12. SMACNA HVAC Duct Construction Standards – Metal and Flexible
13. UL 900 Standard for Air Filter Units
14. UL Fire Resistance Directory
15. UL 705 Power Ventilation

**1.05 REGULATORY REQUIREMENTS:**

- A. Refer to Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, for requirements.

**1.06 SUBMITTALS**

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Shop Drawings: Submit assembly, erection, and installation drawings. Include foundation, platform, and curb details as applicable.

- C. Product Data: Submit manufacturer's product data for each fan, including fan performance curves, sound power ratings, and electrical characteristics.
- D. Operation and Maintenance Data: Submit manufacturer's operation and maintenance instructions in accordance with Section 01 78 23 - Operation and Maintenance Data. Include parts and special tools lists.
- E. Test Reports: Submit certified test reports for the fans and field test results for installed products.
- F. Submit Foundation Data.

## **1.07 QUALITY ASSURANCE**

- A. Sound Power Level Ratings: Comply with AMCA 301. Test fans in accordance with AMCA 300. Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA 210.
- C. Work Quality: Conform to Applicable requirements of AMCA 99.

## **PART 2 - PRODUCTS**

### **2.01 FANS - PRODUCT REQUIREMENTS**

- A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.
- B. Fan Wheel: Fan wheels shall be statically and dynamically balanced. Maximum fan wheel tip speeds shall not exceed manufacturer's designed maximum speed for required duty. The wheels shall be designed so that the critical speed is at least 25 percent greater than the maximum design speed.
- C. Fan Shaft: Turned, ground, and polished steel, designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class. Secure fan wheel and driving pulley to the shaft with keys and set screws.
- D. Pulleys: V-belt drive fans shall be provided with an adjustable pitch motor pulley up through 10 hp. Pulleys shall be cast steel sized for a 1.2 service factor. Belts shall be oil resistant, nonsparking, and nonmetric rated for 150 percent of drive motor horsepower. Drive pulley shall be replaced if necessary to have fan deliver required air volume.
- E. Belt Guards: Provide galvanized steel belt guards for motors mounted on the outside of the fan cabinet. Belt guards for outdoor units shall be fully enclosed.
- F. Shaft Bearings: Provide type indicated, having a median life "Rating Life" AFBMA (L50) of 200,000, calculated in accordance with AFBMA 9 for ball bearings and AFBMA 11 for roller bearings.

- G. Motors: Motors shall be totally enclosed fan cooled in compliance with Section 20 60 13 - Motors for Facility Services, and shall have electrical ratings as indicated. Motor shall be mounted on adjustable base for belt driven fans.
- H. Vibration Isolators: Fan shaft bearing and motor shall be mounted on vibration isolators to structural steel supports, which shall be attached to the fan scroll or frame. Structural steel shall be factory coated with Engineer-approved corrosion-resistant coating system.
- I. Fan Nameplates: Provide with each fan indicating area served, cfm, hp, rpm, sp, and size of unit. Nameplates shall be in accordance with Section 20 40 13 - Identification for Facility Services.
- J. Battery Room Exhaust Fans: Provide with explosion-proof motors and spark-proof construction, AMCA 99-0401, type B. Epoxy coat inside of fan housing.

## **2.02 CENTRIFUGAL UTILITY FANS**

- A. Provide factory-manufactured, factory-assembled, and factory tested centrifugal fans complete with fan wheel, fan shaft, bearings, drive, motor, and accessories as herein specified.
- B. Non-overloading type fans shall be of steel construction and shall have fan wheels with backward inclined steel construction with smooth curved inlet flange or airfoil blades combined with a heavy backplate and spun wheel cone selected for air flow rates above 4,000 cfm. Forward curved type fans, steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of air flow selected for air flow rates up to 4,000 cfm, shall have fan wheels with die-cast blades formed to provide identical exact shapes, and venturi style inlet cone.
- C. Inlet collars shall extend beyond fan housing sufficiently to provide connection to duct through a flexible connection. Fan inlets shall be double curved and streamlined to provide full smooth airflow to the wheel.
- D. Fan outlets shall be provided with removable angles and bolts for attaching flexible connections.
- E. Fan housings shall be constructed of heavy gage steel braced to provide stiffness to housing and rigid support for bearings. Housings shall be provided with access panels and drain plugs. Access panels on supply fans located downstream of heating or cooling coils shall be raised type suitable to receive insulation. Housing supports shall be of one-piece welded construction. Removable galvanized steel screens shall be provided for exposed inlet and discharge outlet openings into fan housings including fans in built-up plenums.
- F. Provide outdoor fans with weather covers for motor and drive. Weather covers shall be provided with ventilation slots, and finished with weather-resistant baked enamel. Covers shall be easily removable for inspection and service.
- G. Bearings shall be heavy-duty pillow block, self-aligning ball or roller, and antifriction type. Bearings 4 inches and larger shall have minimum two rows of spherical roller bearings contained in split pillow block, grease-lubricated ball bearing with ABMA 9 (L10 life at 50,000 hours), or roller bearing ABMA 11 (L10 life at 120,000 hours).

- H. Shafts: Hot-rolled steel, ground and polished, with keyway, protectively coated with lubricating oil and shaft guard.
- I. Accessories:
  - 1. Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.
  - 2. Adjustable Inlet Vanes: Steel construction with blades (supported at both ends) (cantilevered) with two permanently lubricated bearings, variable mechanism (out of air stream) terminating in single control lever with control shaft for double width fans (and locking quadrant).
  - 3. Discharge Dampers: (Parallel) (Opposed) blade heavy-duty steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
  - 4. Inlet/outlet Screens: Galvanized steel, with welded grid.
  - 5. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.
  - 6. Scroll Drain: 1/2 inch steel pipe, coupling welded to low point of fan scroll.

## **2.03 TUBULAR CENTRIFUGAL FANS**

- A. Provide factory-assembled and tested tubular centrifugal fans complete with fan housing, fan wheel, fan shaft, bearings, drive, motor, and accessories as hereinafter specified.
- B. Provide fan wheels having die-formed airfoil blades welded to a heavy backplate and spun wheel cone, statically and dynamically balanced.
- C. Housing shall be welded tubular steel construction with inlet and outlet flange connection and companion flanges. Fan inlet shall be streamlined with conversion vanes to minimize turbulence and to provide smooth discharge airflow. Removable galvanized steel screens shall be provided for exposed inlets and discharge outlets.
- D. Provide pillow-block type ball or roller antifriction type bearings. Motor or fan bearings, drive shaft, and V-belt drive shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated with extended lubrication lines to grease fittings outside of the fan housings.
- E. Accessories for fans shall be as indicated, with weatherproof covers and bolted access doors.
- F. Locate access doors over the wheel in an accessible position, hinged and having latch-type handles; flush mounted for uninsulated housings, raised-mounted for insulated housings.

## **2.04 AXIAL VANE FANS**

- A. Axial vane fans shall be V-belt or direct-driven with fixed blades.

- B. Housings shall be fabricated from hot-rolled finished steel 14-gage minimum thickness.
- C. End flanges shall be continuously welded around periphery of housings. Housings shall be continuously welded, and expanded by mechanical means to ensure concentric forming.
- D. Fan rotor hubs and blades shall be cast aluminum. Fan blades airfoil shall be shaped for maximum efficiency and shall vary in twist and width from hub to tip to obtain equal air distribution along blade length. Blade tip clearance to fan housing shall not exceed 0.05 inch for fan rotor sizes 36 inches and smaller, and 0.1 inch for larger rotor sizes.
- E. Critical speed shall be at least 125 percent of maximum design speed. Maximum operating speed shall not exceed 90 percent of maximum design speed and shall not be a whole number derivative of the critical speed or the natural resonance frequency of the blade.
- F. Rolled steel companion flanges shall be provided for both ends for connecting sheet metal and flexible duct connectors as required.
- G. Manufacturer's standard inlet bell and discharge cone fittings shall be provided where indicated. Inlet bells shall be aluminum with minimum thickness of 3/32 inch for 36-inch diameter and smaller fans, and minimum thickness of 1/8 inch for fans with diameters larger than 36 inches. Discharge cones shall be steel, 14 gage minimum. Inlet bells shall have drilled flanges for connection to fan flanges.
- H. Bearings, motors, and shafts shall be as specified for centrifugal fans.

## **2.05 POWERED ROOF EXHAUST FANS**

- A. Unless otherwise indicated, all roof exhaust fans shall have a louvered housing of aluminum construction and a hinged top to allow unrestricted access to fan drive. Louver blades shall incorporate an integral storm-proofing lip. Blades shall be arranged vertically in an extended stacking design beyond the shoulder of the roof curb. Fan housing shall be provided with a factory installed wire mesh aluminum bird screen. Each exhaust fan shall be provided with a self-flashing sound attenuating roof curb.
- B. Powered roof exhaust fans shall be silhouette type complete with housing, bird screen, motor, and UL-listed disconnect switch inside the dome housing. Sound attenuating roof curb shall be provided for each fan.
- C. Aluminum backdraft damper shall be provided for each exhaust fan as follows:
  - 1. Exhaust fan with louvered housing shall have perimeter type backdraft damper, gravity actuated, aluminum multiple blade construction, felt-edged offset hinge pin, and nylon bearings.
  - 2. Each exhaust fan with spun aluminum housing shall have roof curb base mounted, counterbalanced type backdraft damper, and resiliently mounted motor.
- D. Exhaust fans shall be belt-driven or direct-driven as indicated. Motor mounting on belt-driven units shall be adjustable for correction of belt tension. Provide disconnect switch, factory wired, non-fusible, in housing for thermal overload protected motor.

- E. Roof Curbs: Provide prefabricated, heavy-gage, galvanized steel; mitered and welded corners; 2-inch-thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

## **2.06 GRAVITY ROOF VENTILATORS**

- A. Ventilators shall be low silhouette type with a full perimeter hood opening for exhaust relief. Ventilators shall be constructed of extruded aluminum. Hood and extruded structural members shall have stainless steel anchors and fasteners.
- B. Ventilator shall be designed to have a minimum 1 to 1 ratio of hood perimeter opening to throat area.
- C. Each ventilator shall be provided with a wire mesh galvanized steel bird screen and a gravity aluminum backdraft damper. Counterbalanced backdraft damper shall be mounted in throat of ventilator on a continuous extruded aluminum flange.
- D. Ventilator hood shall be furnished with hinges to swing open from either side for easy access to backdraft damper. A self-flashing roof curb shall be provided with each gravity roof ventilator.
- E. Provide prefabricated roof curbs fabricated from heavy-gage, galvanized steel; mitered and welded corners; 2-inch-thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch wood nailer. Size as required to suit roof opening and ventilator base.
- F. Interface and coordinate the work of this Section with the requirements of Section 07 70 00 - Roof and Wall Specialties and Accessories.

## **2.07 IN-LINE CABINET FAN**

- A. Provide non-overloading type centrifugal fans, with wheel and hub constructed of anodized aluminum.
- B. Provide housing containing fan and motor of reinforced steel, phosphatized and prime painted, with interior surfaces lined with acoustical material secured in place.
- C. Provide shaded pole type motors connected directly to fan. Provide permanently lubricated sleeve bearings and acoustically isolated mounting bracket. Characteristics and accessories shall be as specified in Section 20 60 13 - Motors for Facility Services
- D. Provide gravity type backdraft damper integral to housing, with rubber sealed blade secured to a shaft.

## **2.08 PROPELLER FANS**

- A. Propeller fans shall have wheels constructed of either steel or aluminum blades with hubs, mounting rings and plates that are cast or die formed, and with smooth curves where the air enters the wheels.

- B. Propeller fans shall be provided complete with motors and fan guards. Fans and motors shall be mounted on resilient supports and heavy steel frame. Steel angles and plates shall be provided to mount fans and dampers in wall openings. Mounting plates shall be designed to prevent distortion and shall be either turned up at edges or braced with steel angles.
- C. Shafts for fans shall be steel. Bearings for fan shafts shall be permanently lubricated, permanently sealed, ball bearings.
- D. Accepting fan wheels mounted on either extended motor shafts or ball-bearing hubs that rotate on fixed stub shafts, support shafts by two self-aligning bearings.
- E. Each unit shall be provided with gravity backdraft damper recessed in the wall, with aluminum blades, steel frame, mounted on discharge side of fan, of same manufacturer as fan.
- F. Fans shall be belt-driven or direct-driven as indicated. Motor mounting for belt-driven units shall be resilient and shall be adjustable for correction of belt tension.
- G. Propeller fan shall have a motor with nameplate rating not less than the brake horsepower required to drive the fan with a static pressure 0.20 inch greater than the indicated value.
- H. Fan guard (motor side) shall be removable 1/2 inch by 1/2 inch galvanized wire mesh screen.

## **2.09 WALL EXHAUST FANS**

- A. Wall exhaust fans shall be low silhouette type complete with spun-aluminum housing, wheel guard, disconnect switch, and resiliently mounted motor. Drive assembly shall be mounted on vibration isolators.
- B. Ventilator housing shall be spun-aluminum construction and shall be provided with a rubber grommet internal wiring passage. Exhaust air shall discharge in a 360 degree pattern. Fans shall be provided with attachment collar or angle ring to receive through-the-wall sleeve.
- C. Fans shall be directly driven backward curved non-overloading centrifugal design.
- D. Provide each fan with an aluminum counterbalanced backdraft damper, gravity activated and 1/2 inch mesh thick aluminum wire bird screen unless otherwise indicated.

## **2.10 VARIABLE VOLUME UNITS**

- A. Basic Assembly:
  - 1. Casings: Minimum 22 gage (0.8 mm) galvanized steel; maximum casing leakage: 3 percent of design air flow at 6 inches (1.25 kpa) minimum inlet static pressure.
  - 2. Lining: Minimum 3/4 inch (19 mm) thick neoprene or vinyl coated fibrous glass insulation, 1.5 lb/cu ft (24 g/l) density, meeting NFPA 90A requirements and UL 181 erosion requirements.
  - 3. Plenum Air Inlets: Round stub connections for duct attachment.



4. Plenum Air Outlets: Slip and drive connections.

B. Basic Unit:

1. Configuration: Air volume damper assembly and control components inside unit casing.
2. Volume Damper: Constructed of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches rated inlet static pressure.
3. Mount damper operator to position damper as indicated.

C. Regulator:

1. Location: Locate air volume damper and automatic flow control assembly inside unit casing.
2. Construction: Extruded aluminum or 20 gage (0.9 mm) galvanized steel components; key damper blades into shaft with nylon fitted pivot points.
3. Automatic Flow Control Assembly: Combine spring rates matched for each volume regulator size with machined dashpot for stable operation.
4. Volume Control Damper: Air volume control damper shall be factory-calibrated assembly, consisting of damper and damper shaft extension for connection to externally mounted control actuator.
5. Internally mounted electric actuator with pilot positioner: Position damper as (normally) indicated.

- D. Multi Outlet Adapter Section: Provide with 8-inch (200 mm) diameter collars, each with butterfly balancing damper with lock.

E. Hot Water Heating Coil:

1. Construction: ½ inch (13 mm) copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig (10380 kPa) pressure, factory installed.
2. Capacity: Based on 180 degrees F entering water, 160 degrees leaving water and 50 percent total air volume.

F. Electric Heating Coil:

1. Constriction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
  - a. Primary and secondary over-temperature protection.
  - b. Minimum airflow switch.
  - c. Electric switches and relays. Magnetic contactor for each step of control.

G. Automatic Damper Operator:

1. Electric Actuator: 24 volt with remote temperature read and reset capability.

**PART 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Install fans level and plumb, in accordance with manufacturer's installation instructions. Support units as herein specified, using the vibration control devices as specified in Section 20 30 13 - Vibration, Isolation and Seismic Control for Facility Services. Secure fans with galvanized or cadmium-plated hardware. Provide supporting steel, mounting curbs, and anchorage devices as required to properly support the unit.
- B. Install suspended units independently from building structure using threaded steel rods and vibration isolators, unless otherwise indicated.
- C. Rigidly anchor roof-mounted units to roof curbs using galvanized or cadmium-plated hardware.
- D. Make final connections to ductwork using flexible connectors. Secure flexible duct connectors mechanically to fan and duct to provide airtight joints. Install 1/2-inch mesh bird screen on discharge of weather hood downstream from discharge shutter.

**3.02 START-UP SERVICE**

- A. Provide the services of a factory-authorized service representative to inspect the installation and connections and to provide initial start-up service. Services shall include a complete operational check and demonstration of the equipment operation to ensure proper operation.

**3.03 TRAINING:** Provide instructions to the District's maintenance personnel on proper operation and maintenance procedures in accordance with Section 01 79 00 - Demonstration and Training.

**3.04 FIELD QUALITY CONTROL**

- A. Perform start-up tests of air-handling units for proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM. Replace fan and motor pulleys as required to achieve design conditions. Measure and record motor electrical values for voltage and amperage. Shut unit down and reconnect automatic temperature control operators as applicable. Perform tests in accordance with the respective manufacturer's instructions and applicable codes and standards.
- B. The Engineer will review certificates of compliance and test reports, and witness all tests. Submit certified test results as specified in Article 1.06 herein.
- C. Refer to Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC, for air-handling-system testing, adjusting, and balancing requirements and procedures.

**END OF SECTION 23 34 00**